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ELECTROMAGNETIC RADIATION SYSTEM (EMRS) FOR SUSCEPTIBILITY TEST--ETC(U)
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RESEARCH AND DEVELOPMENT TECHNICAL REPORT
CORADCOM- 76-0332-10



# ELECTROMAGNETIC RADIATION SYSTEM (EMRS)

# FOR SUSCEPTIBILITY TESTING

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number):
The function of the Electromagnetic Radiation System (EMRS) is to generate electromagnetic energy to produce a constant field strength that can be automatically scanned as a function of frequency. The design objective is to cover the frequency range of 30 Hz to 40 GHz with field intensities up to 200 volts per meter. This report describes system equipment status and results of performance tests in the demonstration frequency ranges of 30-60 MHz, 1.0-2.1 GHz, 2.1-4.0 GHz and 12.4-18.0 GHz.

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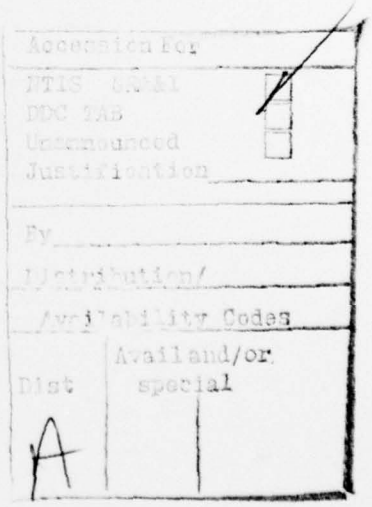
## I. INTRODUCTION

This report describes the activities and developments concerning PHASE II of the Electromagnetic Radiation System (EMRS) Program during the period of 1 January 1979 through 31 March 1979. The purpose of Phase II of the EMRS program is to develop the hardware to demonstrate the feasibility of the theoretical design considered in Phase I.

## II. STATUS OF EMRS EQUIPMENT

All major equipment comprising the EMRS demonstration system has been received, with the exception of the tunable bandpass filter for the 12.4 GHz to 18.0 GHz frequency range. This item is expected to be delivered during May 1979.

The tunable bandpass filter for the 2.1 GHz to 4.0 GHz frequency range had to be returned to the manufacturer for repairs. The repaired unit is expected to be returned to AEL during April 1979.



## III. PROGRESS DURING REPORT PERIOD

During this period, the Hewlett-Packard 8495H programmable attenuator, which was returned to the manufacturer for repair, was returned to AEL in proper operating condition. It was reinstalled in the EMRS control panel and used in applicable system tests.

Work continued on the redesign and finalization of the AEL-built external automatic levelling loop circuit.

Tests of the system were performed, in accordance with the EMRS Test Plan dated July 1978, to measure functions which required the tunable filters received so far. Results of tests, for all four demonstration bands, are shown in Tables 1 through 4, and summarized as follows:

Table 1 shows that the 30 MHz to 60 MHz EMRS demonstration system met requirements specified in the test plan for the following tests: Frequency Accuracy, Scan Rate Limits, External AM and FM Modulation, High Level Radiated Output and Level Variation, Non-Radiated Output and Level Variation and Signal Purity. It did not meet all requirements for External Pulse Modulation and Low Level Radiated Output.

Table 2 shows that the 1 GHz to 2.1 GHz EMRS demonstration system met requirements specified in the test plan for the following tests: Frequency Accuracy, Scan Rate Limits, External AM Modulation, most External FM Modulation, High Level Radiated Output and Level Variation, Non-Radiated Output and Level Variation and Signal Purity. It did not meet all requirements for External FM Modulation, External Pulse Modulation and Low-Level Radiated Output.

During tests of the 1 GHz to 2.1 GHz tracking filter, it was found that the method used to detect and track the RF signal input to the tracking filter limits the modulation to some degree. An investigation was conducted to determine and define the limitations. It was found that the only type of modulation which

was affected because of the filter was FM, and that the only limitation was in FM deviation. FM deviation with the filter was limited to a maximum of ± 32 MHz, which meets all specified limits except the requirement for ± 75 MHz deviation with modulation frequencies of DC to 100 Hz.

Table 3 shows that the 2.1 GHz to 4.0 GHz EMRS demonstration system met requirements specified in the test plan for the following tests: Frequency Accuracy, External FM, High Level Radiated Output and Level Variation and Non-Radiated Output and Level Variation. It did not meet all requirements for External AM, External Pulse Modulation and Low Level Radiated Output and Level Variation. Tests for Scan Rate and Signal Purity, in this frequency range, will be performed after the tunable filter is repaired by the manufacturer and returned to AEL. Additional tests will be performed at that time to make certain that high level radiated output, with the filter installed, complies with the 200 volt per meter requirements. Tests will also be performed to determine whether installation of the filter imposes any limitations on modulation capabilities.

Table 4 shows that the 12.4 GHz to 18 GHz EMRS demonstration system met requirements specified in the test plan for the following tests: Frequency Accuracy, External AM, External FM, High Level Radiated Output and Level Variation and Non-Radiated Output and Level Variation. It did not meet all requirements for External Pulse Modulation. Tests for Scan Rate, Low Level Radiated Output and Signal Purity will be performed after the tunable filter is received from the manufacturer. Tests will also be performed to determine whether installation of the filter imposes any limitations on high level radiated output or on modulation capabilities.

## IV. FUTURE PLANS

During the next reporting period, the following activities are anticipated:

1. Finalization of the external automatic levelling circuit and tests of its performance relative to all EMRS frequency bands.
2. Receipt of the repaired 2.1 GHz to 4 GHz filter and performance of tests which require it.
3. Receipt of the 12.4 GHz to 18 GHz filter and performance of tests which require it.
4. Finalization of the EMRS system and quality control inspection.
5. Completion of test report to reflect tests to be performed in the next period.
6. Preparation of other required software on the finalized EMRS system.

TABLE 1 - SUMMARY OF EMRS TEST RESULTS, 30-60 MHZ FREQUENCY BAND

| TEST PLAN PARA. | TEST DESCRIPTION | REQUIREMENT | RESULTS |
|---|---|---|---|
| 5.1.2 | Frequency Accuracy | Manual: ± 10 MHz<br>Auto: ± 15 MHz | Meets requirements<br>Meets requirements |
| 5.1.3 | Scan Rate Limits (Automatic Sweep) | Less than or equal to 5 seconds/octave to over 100 seconds per octave | Meets requirements |
| 5.1.4 | External Modulation: | | |
| | AM | 0-100%, DC-150 kHz | Meets requirements |
| | FM | ± 20 MHz, DC-100 Hz<br>± 5 MHz, 100Hz-1MHz<br>± 2 MHz, 1-2 MHz | Meets requirements<br>Meets requirements<br>Meets requirements |
| | Pulse, Rise Time | 50 nanoseconds | 20 nS minimum with internal levelling (Note 1) |
| | Pulse, Fall Time | 50 nanoseconds | Over 20 nS with internal levelling (Note 1) |
| | Pulse Width | 50 nS - 50 mS | 100 nS - 20 mS with internal levelling (Notes 1 and 2) |
| 5.1.5 | Radiated Output: | | |
| | High | 200 V/M ± 3 dB | Meets requirements |
| | Low | 1 mV/M ± 3 dB | (Note 3) |
| 5.1.6 | Non-Radiated Output | 10 watts ± 3 dB | Meets requirements |
| 5.1.7 | Signal Purity | Harmonic & spurious emission at least 100 dB below fundamental | Meets requirements |

NOTES:
1. With external levelling, to much overshoot and ringing occurred. Levelling circuit is being redesigned.
2. System functions with longer pulses but output level varies if duty cycle exceeds 50%. Meets requirements with lower duty cycle.
3. System dynamic range is 40 dB, for 2 V/M minimum output. Adding external Hewlett-Packard 8447D amplifier to levelling loop adds 26 dB to dynamic range, for a minimum of 100 mV/M.

TABLE 2 - SUMMARY OF EMRS TEST RESULTS, 1-2.1 GHZ FREQUENCY BAND

| TEST PLAN PARA. | TEST DESCRIPTION | REQUIREMENT | RESULTS |
|---|---|---|---|
| 5.2.2 | Frequency Accuracy | Manual: ± 10 MHz<br>Auto: ± 15 MHz | Meets requirements<br>Meets requirements |
| 5.2.3 | Scan Rate Limits (Automatic Sweep) | Less than or equal to 5 seconds/octave to more than 100 seconds per octave | Meets requirements |
| 5.2.4 | External Modulation: | | |
| | AM | 0-100%, DC-150 kHz | Meets requirements |
| | FM | ± 75 MHz, DC-100 Hz<br>± 5 MHz, 100Hz-1MHz<br>± 2 MHz, 1-2 MHz | (Note 1)<br>Meets requirements<br>Meets requirements |
| | Pulse, Rise Time | 50 nanoseconds | 20 nS minimum with internal levelling (Note 2) |
| | Pulse, Fall Time | 50 nanoseconds | Over 20 nS with internal levelling (Note 2) |
| | Pulse Width | 50 nS - 50 mS | 100 nS - 20 mS with internal levelling (Notes 2 and 3) |
| 5.2.5 | Radiated Output: | | |
| | High | 200 V/M ± 3 dB | Meets requirements |
| | Low | 1 mV/M ± 3 dB | (Note 4) |
| 5.2.6 | Non-Radiated Output | +30 dBm ± 3 dB | Meets requirements |
| 5.2.7 | Signal Purity | Harmonic & spurious emission at least 100 dB below fundamental | Meets requirements |

NOTES:
1. With filter installed, deviation is limited to ± 32 MHz.
2. With external levelling, too much overshoot and ringing occurs. Levelling circuit is being redesigned.
3. System functions with longer pulses, but output level varies if duty cycle exceeds 50%. Meets requirements with lower duty cycle.
4. System dynamic range is 44 dB, for 1.3 V/M minimum output.

TABLE 3 - SUMMARY OF EMRS TEST RESULTS, 2.1-4.0 GHZ FREQUENCY BAND

| TEST PLAN PARA. | TEST DESCRIPTION | REQUIREMENT | RESULTS |
|---|---|---|---|
| 5.3.2 | Frequency Accuracy | Manual: ± 20 MHz<br>Auto: ± 30 MHz | Meets requirements<br>Meets requirements |
| 5.3.3 | Scan Rate Limits (Automatic Sweep) | Less than or equal to 5 seconds/octave to more than 100 seconds/octave | Awaiting delivery of filter |
| 5.3.4 | External Modulation: | | |
| | AM | 0-100%, DC-150 kHz | See Note 1 |
| | FM | ± 75 MHz, DC-100 Hz<br>± 5 MHz, 100 Hz - 1 MHz<br>± 2 MHz, 1-2 MHz | Meets requirements |
| | Pulse, Rise Time | 50 nanoseconds | 20 nS minimum with internal levelling (Note 2) |
| | Pulse, Fall Time | 50 nanoseconds | Over 20 nS with internal levelling (Note 2) |
| | Pulse Width | 50 nS - 50 mS | 100 nS - 20 mS with internal levelling (Notes 2 and 3) |
| 5.3.5 | Radiated Output: | | |
| | High | 200 V/M ± 3 dB | Meets requirements |
| | Low | 1 mV/M ± 3 dB | See Note 4 |
| 5.3.6 | Non-Radiated Output | +30 dBm ± 3 dB | Meets requirements |
| 5.3.7 | Signal Purity | Harmonics and spurious emission at least 100 dB below fundamental | Awaiting delivery of filter |

NOTES:
1. Modulation applied directly to generator limited to 60% maximum. Modulation applied to external AM circuitry will go to 100% but distortion is high (many extraneous signals).
2. With external levelling, too much overshoot and ringing were found. Levelling circuit is being redesigned.
3. System functions with longer pulses, but output level varies if duty cycle exceeds 50%. Meets requirements with lower duty cycle.
4. System dynamic range is 40 dB, for 2 V/M minimum output.

TABLE 4 - SUMMARY OF EMRS TEST RESULTS, 12.4 GHZ - 18 GHZ FREQUENCY RANGE

| TEST PLAN PARA. | TEST DESCRIPTION | REQUIREMENT | RESULTS |
|---|---|---|---|
| 5.4.2 | Frequency Accuracy | Manual: ± 50 MHz<br>Auto: ± 70 MHz | Meets requirements<br>Meets requirements |
| 5.4.3 | Scan Rate Limits (Automatic Sweep) | Less than or equal to 5 seconds/octave to more than 100 seconds/octave | Awaiting delivery of filter |
| 5.4.4 | External Modulation: | | |
| | AM | 0-100%, DC-150 kHz | Meets requirements |
| | FM | ± 75 MHz, DC-200 Hz<br>± 5 MHz, DC-200 kHz | Meets requirements |
| | Pulse, Rise Time | 50 nanoseconds | 30 nS with both external and internal levelling |
| | Pulse, Fall Time | 50 nanoseconds | 70 nS with external levelling, 4 uS with internal levelling |
| | Pulse Width | 50 nS - 50 mS | 100 nS - 10 mS with internal and external levelling |
| 5.4.5 | Radiated Output: | | |
| | High | 200 V/M ± 3 dB | Meets requirements |
| | Low | 1 mV/M ± 3 dB | Awaiting delivery of filter |
| 5.4.6 | Non-Radiated Output | +30 dBm ± 3 dB | Meets requirements |
| 5.4.7 | Signal Purity | Harmonics and spurious emission at least 100 dB below fundamental | Awaiting delivery of filter |